TWENTY STEPS TO WRITING A RESEARCH ARTICLE

Beth A. Fischer and Michael J. Zigmond
Survival Skills and Ethics Program
University of Pittsburgh

The process of moving from idea to published manuscript can be a daunting one. Here we break that process into a series of steps designed make this essential task more manageable.[1] If 20 steps is too much to manage, focus on the 13 steps that we have marked with an asterisk (*) – these cannot be skipped!

1. Determine the authors

When designing a research project, we recommend preparing an initial list and order of authors. Such a list authors should be based on established guidelines[2] and should make explicit the estimated contribution of each individual to the project.

A list of authors will ensure that all individuals to be involved in the project understand at the outset whether or not they can expect to be an author and, if so, who their contribution is to be. It should be viewed as a tentative list, as the final version should reflect actual contributions to the work. (Also, there may also be more than one list as it might be anticipated that more than one paper will derive from a given project.)

2. Start writing before the experimental are complete

Starting writing while you are still doing the experiments. Writing often evokes new ideas: you may realize that there are additional experiments to run or additional controls that you need to add. If you wait until you are done in the lab, have dismantled the equipment, and possibly moved on to another position, you will not have the opportunity to test these ideas.

3. Decide it is time to publish

It is time to publish when your findings represent a complete story (or at least a complete chapter), one that will make a significant contribution to the scientific literature. Simply collecting a given amount of data is not adequate.

---

[1]Our list has been modified and expanded from a list provided by the Council of Biological Editors (1968).

[2]We recommend that every research group establish and make known to its members the criteria that will be for authorship on papers resulting from the work to be conducted. In so doing, the group may wish to make use of existing guidelines. (See our essay on *Components of a Research Article.*)

4. Draft a title & abstract

Drafting a working title and an abstract helps define the contents of the paper, identifying which experiments you will publish in this paper, and which studies you will save for inclusion in another paper. (See our *Component of a Research Article* on the preparation of these two items.)

*5. (Re)examine the list of authors

When you have now determined which experiments will be included in this paper you must select the authors and the order in which they will appear. If you have followed our advice to this point, you already have such a list. Reevaluate it based on the contributions that were made to those experiments and the additional contributions that will be made through the preparation of the manuscript. If a list already exists, make adjustments should be made to ensure compliance with your guidelines[2]. Of course, any changes should be done with caution and tact.

6. Determine the basic format

There are three basic formats for peer-reviewed research articles:

Full-length research articles: These articles contain a comprehensive investigation of the subject matter and are viewed as the standard format. It uses the "IMRAD" format – Introduction, Methods, Results, and Discussion. (See our "Components of a Research Article.")

Short (or brief) communications: While not as comprehensive in scope as full-length research articles, these papers also make a significant contribution to the literature. Their length will be set by the journal but is usually 3500 words or less and will contain up to 1-2 tables and figures. Unlike full papers, methods, results, and discussions may be combined into a single section.

Rapid communications: These articles quickly disseminate particularly "hot" findings, usually in a brief communication format. Articles that have immediate implications for public health would be appropriate for such a format, as might findings in a highly competitive and quickly moving field.

7. Select the journal

There are several factors to consider when choosing a journal. It is unlikely that one journal will have all of the features you are looking for, so you may have to compromise. However, there is one essential feature that you should not compromise on – *manuscripts must be peer reviewed for publication if they are to be considered research articles*.

Language: English has become the dominant form for international scientific communication. Thus, if you are interested in communicating your results widely

to the international scientific community, then it is essential to publish in English. If, on the other hand, you wish to communicate to a more localized community (e.g., physicians in a particular geographical area), you might chose a journal that permits another language.

Focus: What type of research does the journal publish? Is its focus broad or narrow? Which disciplines are represented? What is the journal's orientation – for example, is it clinical or basic, theoretical or applied?

Indexing: Is the journal indexed in the major electronic databases such as Medline, Biological Abstracts, Chemical Abstracts, or Current Contents?

Availability: Is the journal broadly available? Is there an online version of the journal? Are papers provided in pdf format?

Reputation: Although it can be rather subjective, there are several ways to gauge the reputation of a journal. Ask colleagues which journals they respect. Look at recent articles and judge their importance. Check the members of the Editorial Board and determine if they are leaders in their fields. Determine the journal's *impact factor*[3] Try to find out the acceptance rate of the journal.

Format: Do like the appearance of published articles – the format, typeface, and style used in citing references? If relevant, does the journal publish short and/or rapid communications?

Figures: Do figures published in the journal have the resolution that you need?

Time to Print: Using the "date submitted" and a "date accepted" that are published on the article, along with the date of the issue, you can estimate the length of the review process as well as the time from acceptance to publication in print.

Charges: Some journals bill the author for *page charges*, a cost per final printed page. Most journals have a separate *charge for color plates*. This may be as much as $1000 per color plate. Many journals will waive page charges if this presents a financial hardship for the author; color plate charges are less readily waived and would at least require evidence that the color is essential to the presentation of the data (e.g., to show a double-labeled cell).

[3]*Impact factor* is an annual measure of the extent to which articles in a given journal are cited. How selective is the journal in accepting papers for publication? Note however, these ratings can be artificially inflated in journals that publish review articles, which tend to be cited more than research articles. See www.isinet.com)

Once you decide on a journal, obtain and read that journal's *Instructions to Authors.* This document describes the format for your article and provides information on how to submit your manuscript. You can usually obtain a copy of the journals' Instructions to Authors on their website or in the first issue of a new volume.

8. Stock the sections of your paper

As you think about your paper, store relevant material in folders marked *Introduction*, *Methods*, *Results*, and *Discussion*. This will save time and avoid frustration when the writing begins. Stored items might include figures, references, and ideas.

*9. Construct the tables, figures, and legends

Yes, figures and tables *before* the writing begins! The entire paper should be organized around the data you will present. By preparing the tables, figures (and their legends and appropriate statistical analyses), you will be certain of your results before you worry too much about their interpretation. You also may be able to determine if you have all the data you need. Note: Except under unusual circumstance, *you may **not** include any data that your have already published*. (See *Components of a Research Paper*.)

*10. Outline the paper

An outline is like a road map. An outline details how you will get from here to there, and helps ensure that you take the most direct and logical route. *Do not start writing without it*! If you have co-authors, you may wish to get feedback from them before you proceed to the actual writing phase. And if you have "stocked" your sections (Step 8), those files should be useful here and in the writing that follows.

*11. Write the first draft

Write the first draft of the entire manuscript.[4] *Components of a Research Article* discusses what goes into each section of the manuscript. For a more extensive presentation of this and many other aspects of preparing a paper see Day (1998). At this point, do not worry about it being intelligible. That comes later

Some people recommend that you begin your writing with the Introduction and continue through in order each section of the paper. This can help ensure flow. However, others suggest that you start wherever you wish – anything to get rid of that blank screen or piece of paper. What ever your approach, heed the advice of Charles Sides (1991): "If you try to write and edit at the same time, you will do neither well." And because editing

[4]If you are writing with coauthors, you may wish to assign different aspects of the manuscript to different authors. This can save time, allow more individuals feels that are making substantive contributions to the writing process, and ensure the best use of expertise. However, it also can lead to a mixture of styles. Thus, if you take this approach, be certain that the final product is carefully edited to provide a single "voice."

is often a lot easier than writing, push through this step as quickly as possible. If you are taking much more than two full days, you have probably paused to edit!

*12. Revise the manuscript

This step involves three major tasks, each to be carried out in the order given:

> ***(1) Make major alterations***: Fill in gaps, correct flaws in logic, restructure the document to present the material in the most logical order.
>
> ***(2) Polish the style***: Refine the text, then correct grammar and spelling.
>
> ***(3) Format the document:*** Make your manuscript attractive and easy to read

It is important to do the tasks in the stated order. Otherwise, you may find yourself spending a lot of time revising material that you later delete.

13. Check the references

Ensure that the citations are correct and complete. Do one last literature search to make certain that you are up to date. (See our *Components of Research Article* on the matter of reference selection.)

*14. Write the final title and abstract

Many changes are made during the editing process. Make certain that your title and abstract match the final version of your article.

*15. Re-read the journal's Instructions to Authors

Review the details of how the manuscript is to be formatted and submitted. Revised where necessary

*16. Prepare the final illustrations

Ensure that your tables, figures, and figure legends are complete, clear, self-contained, and in the format required by the journal. Do not allow *any* chance for misunderstanding.

*17. Get feedback on your manuscript and then revise your manuscript again

Getting feedback is one of the most important things that you can do to improve your article. First, be sure your co-authors have had a chance to read and comment on the draft. Then, when it is ready, give the manuscript to some colleagues. Indicate to when you would like to receive their comments, and what levels of information you would like (e.g., comments on the science, logic, language, and/or style). After you get their comments, revise your manuscript to address their concerns. Do not submit your manuscript until you feel it is ready for publication. Once it is accepted, further changes

in your manuscript will be difficult and may also be costly.

*18. Submit the manuscript to the editor

Follow the Instructions to Authors to determine what items you need to submit, how to submit them, and to whom you should send them. Note that some journals permit (or even require) a "pre-review," i.e., a letter indicating the content of the article so that the editor can determine whether they will accept the manuscript for a full review. At this point you may wish to list possible reviewers (or individuals to be avoided). If necessary, contact the editor to be sure that the manuscript was received. And if after a month you have not received a response concerning the acceptability of your manuscript for publication you may wish to contact the editor about this, too.

*19. Deal with reviewers' comments

Most manuscripts are not accepted on the first submission. However, you may well be invited to resubmit a revised manuscript. If you chose to do so, you will need to respond to the reviewer comments. Do this with tact. Answer every concern of the reviewers, and indicate where the corresponding changes were made in the manuscript if they were, indeed, made. You do not need to make all of the changes that the reviewer recommended, but you do need to provide a convincing rationale for any changes that you did not make. When you resubmit the manuscript, indicate in your cover letter that this is a revised version.

An alternative is to submit the manuscript to another journal. However, if you do so, it may still be best to take the reviewer comments into consideration. Even if you feel that the reviewers have misunderstood something in your paper, others might do the same. Of course, if you submit to another journal you probably will need to modify the format. And please note: You may *not* submit your manuscript to more than one journal at a time!

*20. Check the proofs

Once the manuscript is accepted and prepared for print, the publisher will send the corresponding author page proofs of the article. This may be accompanied by a list of queries, such as missing information regarding a reference. The proofs may be sent via email or as hard copy. If there is a chance that you will be away when the proofs arrive, have a plan for making certain that they are received and you are notified. You may only have 24-48 hr to return the proofs.

Carefully correct any typos and factual errors. And read the manuscript for clarity – this is your last chance! However, try to limit changes to editorial queries plus minor modifications. If you think anything more major is required, you must first get permission from the journal editor and be prepared for additional costs and publication delays.

20+. Celebrate!

As Robert Day says in *How to Write and Publish a Scientific Paper* (1998), "The goal of scientific research is publication….A scientific experiment, no matter how spectacular the results, in not complete until the results are published." Your experiment – at least one phase of it – is now complete. Enjoy the moment!

SELECTED BIBLIOGRAPHY

For a more complete set of references on writing, see our web site (www.survival.pitt.edu).

Council of Biology Editors, Committee on Graduate Training in Scientific Writing (1968) *Scientific Writing for Graduate Students: A Manual on the Teaching of Scientific Writing. New York: Rockefeller University* Press. (This was subsequently revised, see Woodford below.)

Day RA (1998) *How to Write and Publish a Scientific Paper, 5th Edition.* Phoenix: Oryx Press.

Fischer, BA, Zigmond, MJ (2004) *Components of a Research Article*. www.survival.pitt.edu.

Institute for Scientific Information. *www.isinet.com*

Sides C (1991) *How to Write and Present Technical Information.* USA: Oryx Press.

Woodford FP (1999) *How to Teach Scientific Communication.* Reston, VA: Council of Biology Editors.

BA Fischer & MJ Zigmond
www.survival.pitt.edu
survival@pitt.edu
version: July 7, 2004